

# **SUSTAINABLE BUILDING PRACTICES IN CALIFORNIA STATE BUILDINGS**

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Leon Alevantis<sup>1\*</sup>, Kathy Frevert<sup>2</sup>, Rick Muller<sup>3</sup>, Hal Levin<sup>4</sup>, and Arnold Sowell<sup>5</sup>

<sup>1</sup>Indoor Air Quality Section, Calif. Department of Health Services, Berkeley, CA, USA

<sup>2</sup>Green Building Program, Calif. Integrated Waste Management Board, Sacramento, CA, USA

<sup>3</sup>Energy Management Division, Calif. Department of General Services, Sacramento, CA, USA

<sup>4</sup>Building Ecology Research Group, Santa Cruz, CA, USA

<sup>5</sup>Calif. State and Consumer Services Agency, Sacramento, CA, USA

## **ABSTRACT**

The State of California, until recently, did not have a centralized, coordinated effort to define and integrate sustainable building practices in the State's capital outlay design and construction process. Efforts to define and implement these practices started in 1999, when the Legislature required the incorporation of sustainable building measures in a large state office building complex. These successful efforts led to the formation of a multi-agency task force to address sustainable issues for all state buildings. In response to an executive order issued by Governor Gray Davis, the task force prepared a report recommending strategies and action items necessary to incorporate sustainable practices in future state projects. The task force is also working on issues related to sustainable procurement practices. This paper describes how these efforts were originally envisioned, how they were developed and implemented, what barriers were encountered, and the lessons learned during this process.

## **INDEX TERMS**

Policy, Standards and guidelines, Building design and remediation, Construction and renovation, Offices, Sustainable building measures, Building materials

## **INTRODUCTION**

California is one of the most environmentally proactive states in the U.S., and over the years numerous legislative measures have addressed various environmental issues (Alevantis, 2000). Legislatively mandated activities include: (a) guidelines to reduce occupant exposure to volatile organic compounds (VOCs) from building materials; (b) requirements and guidelines for numerous environmental chemicals; (c) energy efficiency and conservation standards for buildings and appliances; and, (d) minimum recycled content requirements for certain products and commodities used in state buildings.

The concept of sustainability, especially in the construction industry, has received significant attention over the last few years. The goals of sustainable practices in California buildings are to: (a) enhance indoor air quality; (b) improve occupant health and productivity; (c) increase the efficient use of energy, material, and water resources; and (d) reduce the environmental

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\* Contact author email: [lalevant@dhs.ca.gov](mailto:lalevant@dhs.ca.gov)

impacts associated with the production of raw materials and the construction, deconstruction, and long-term operation of buildings. This paper describes how the concept of sustainable building practices evolved and is being implemented in the state government, what barriers have been encountered, and the lessons learned during this process.

## **EVOLUTION OF SUSTAINABLE BUILDING EFFORTS IN CALIFORNIA**

The first comprehensive approach to sustainable construction started in 1999, when the State Legislature directed the Department of General Services (DGS) [Project Management Branch (PMB) of the Real Estate Services Division (RES)] to incorporate sustainable practices in the design and construction of a 140,000 m<sup>2</sup> (1.5 million ft<sup>2</sup>) state office building complex in Sacramento, known as the Capitol Area East End Complex (CAEEC) (Department of General Services, 2000). This complex consists of five separate buildings, and is the largest state office building project in the state government's history. To address the Legislature's directive, a multi-agency team, known as the Green Team, was formed under the leadership of the Secretary of the State and Consumer Services Agency and, in partnership with the California Integrated Waste Management Board, California Energy Commission, Department of Health Services, and California Air Resources Board, worked with DGS to develop criteria that were incorporated in the Request for Proposals (RFP) for the CAEEC. These criteria included requirements for improved indoor air quality, energy, materials, water efficiency, construction site management, and the use of recycled content materials. DGS allocated an unprecedented 20% of the total scoring of the design/build applications to experience and innovation in sustainable construction. Based on DGS's RFP, the two selected design/build teams completed the building design, prepared the construction documents, and developed their own sustainable designs and specifications. Some of these specifications and criteria include:

- **Indoor Air Quality:**
  - **Building Materials:** (a) requiring low-emitting building materials tested according to a specified protocol; (b) specifying formaldehyde-free ceiling tiles and paints; and (c) requiring a commissioning plan that includes not only the energy and life safety systems, but also indoor air quality with pre- and post-occupancy air sampling.
  - **Heating, Ventilating, and Air-Conditioning (HVAC) Systems:** (a) specifying airflow monitoring stations and minimum airflow injection fans so that the design minimum amount of outdoor air can always be supplied to each building; (b) specifying higher efficiency air filters (85%) than commonly installed; (c) to the extent possible, eliminating the use of internal lining in the ductwork; (d) requiring that all oil residues be removed from the internal surfaces of the ductwork prior to installation, that the open ends of all ductwork be covered during transportation and storage, and that after installation all open ends be covered; (e) designing the HVAC systems and their components with easy accessibility for inspection and maintenance; and (f) specifying local exhaust for copier rooms.
- **Energy and Resource Efficiency:** (a) exceeding the 1998 California energy code standards by at least 30%; (b) using daylighting features; (c) specifying materials with high recycled contents, recyclability potential, and overall durability; (d) specifying a minimum of 75% by weight of demolition and construction waste be diverted from landfills; and (e) specifying water-efficient irrigation and plumbing systems.

The Green Team continues to consult with DGS during the construction phase of this project to ensure that the sustainable goals set forth in the RFP are implemented during construction. After successfully incorporating sustainable features at the CAEEC and seeking widespread

improvements in all state buildings, Governor Davis issued Executive Order D-16-00 in August 2000, which established the state's sustainable building goal and directed the Secretary of the State and Consumer Services Agency to develop a "roadmap" with recommended strategies on how the state could "...site, design, deconstruct, construct, renovate, operate, and maintain buildings that are models of energy, water, and materials efficiency while providing healthy, productive and comfortable indoor environments and long-term benefits to Californians" (State of California, 2000). To implement the Governor's Executive Order, the Secretary formally convened the Sustainable Building Task Force, a group consisting of more than 32 California state governmental agencies. In December 2001, the Task Force released its report entitled *Building Better Buildings: A Blueprint for Sustainable State Facilities* (State of California, 2001). This report summarizes the current efforts of ten state agencies and departments in the area of sustainability, describes the numerous accomplishments of the Sustainable Building Task Force, and discusses ten recommendations on how to implement the Governor's Executive Order into the state capital outlay process. These recommendations include: (a) modifying the State's capital outlay process to ensure that the Governor's sustainable goals are met; (b) improving the air quality and comfort of indoor spaces, while reducing energy beyond the most current energy code requirements; (c) specifying and selecting environmentally preferred products for construction, as well as for ongoing maintenance; (d) implementing whole-building commissioning practices at start-up and during the life of a building; (e) developing metrics, such as post-occupancy evaluations and measurements, to quantify the benefits of sustainable construction, and to compare them to conventional construction; (f) reducing building and landscaping water usage; and (g) developing training programs for state and local government agencies and partnering with both public and private sector entities.

In addition to addressing sustainable building practices, the State has initiated successfully to incorporate sustainability into product procurement. These efforts started in early 2000, when DGS's Procurement Division was in the process of issuing a request for bids for a 3-yr, \$60 million office workstation contract. By law, state agencies are required to purchase office furniture systems manufactured by the California Prison Industry Authority (PIA). However, if PIA is unable to supply the required product quantity for a specific order, then state agencies may use other existing contracts with private vendors. The Green Team and the CAEEC Management Team realized that due to the size of the CAEEC (about 6,000 workstations) PIA would be unable to supply all the workstations, and therefore the new contract would likely be used for at least part of the CAEEC. As a result, the Green Team worked with DGS, other state agencies, the office furniture industry, and private consultants to issue benchmark environmental specifications for procuring office furniture systems. These *Environmental Specifications for Office Furniture Systems* were issued in December 2000 and included testing and selection criteria for indoor air quality as well as requirements for recycled contents and lighting (Levin et al, 2000). In early 2001, a successful bidder was selected that met the environmental specifications at a price comparable to what the State was paying under the previous contract. Although not required by law, PIA has also recently met the environmental specifications. This successful procurement effort led to the formation of the *Sustainable Procurement Task Force*, another multi-agency group. Using the office furniture systems contract as an example, this Task Force expects to develop environmental specifications for other commodities including carpeting, paints, ceiling tiles, and building insulation.

The experience gained during the development of the specifications for the office furniture systems contract was also utilized by one of the design/build teams at the CAEEC to develop their own *Special Environmental Specifications* (Section 01350) for a variety of building materials (Bernheim et al., 2002). These specifications include: (a) emissions-testing requirements; (b) maximum allowable concentrations for selected volatile organic compounds (VOCs); and (c) certification requirements for recycled content materials to meet the statutorily mandated State Agency Buy Recycled Campaign (SABRC). These specifications have been rewritten for use on other projects and are available on the web (California Energy Commission, 2001; Collaborative for High Performance Schools, 2001).

## **BARRIERS**

A major barrier to implementing sustainable state construction practices is the State's capital outlay process. Since budget change proposals are initiated by numerous state agencies, not DGS, early conceptual design goals and budgets of state building projects may not reflect sustainable concepts and financial requirements. In addition, the lack of tracking and feedback procedures of sustainable measures before and after occupancy of buildings further limits the ability of state agencies to evaluate the benefits of sustainable construction.

Life-cycle costing, rather than first-cost budgeting, is a key component of the sustainable building process. Widely accepted methods are lacking for calculating the long-term "societal" benefits of environmental factors such as improved indoor air quality and the use of recycled content materials in spite of the fact that it has been well documented that the negative impacts of certain environmental factors can be very large. For example, in California, the estimated cost of a conservative 2% decrease in productivity of office workers and teachers reporting eye, nose, and skin irritation, headache, fatigue, and difficulty breathing (Fisk, 2000), is estimated at \$6 billion (State of California, 2001).

Another barrier is the reluctance of the design and construction industry to accept sustainable building practices as the way of the future. Many design and construction firms are unfamiliar with sustainable building practices but are slowly beginning to understand the potential economic and environmental benefits. With various government and private sector entities demanding sustainable building features, companies with experience in sustainable design and construction are more likely to be retained by large-scale clients such as the State of California, thus transforming the market. As demand for sustainable building practices increases, the building industry will have to respond. This market transformation process will be hastened through education, technical assistance, and training. Currently, the DGS and the CIWMB have retained a consultant and are conducting sustainable building seminars for state and local government officials.

Finally, a barrier encountered at the CAEEC is that a few manufacturers were not willing to have their products tested for emissions or to certify them for minimum recycled contents. Most manufacturers, whose products were used in large quantities, provided the required information. On the contrary, some manufacturers whose products were used in small quantities, were not willing to provide the required information due to the additional cost involved. As more projects require that such specifications be met, an increased number of manufacturers will undoubtedly provide such information.

## LESSONS LEARNED

There are several important lessons that have been learned as the State has begun implementing sustainable building practices throughout its design and construction process.

State agencies can effectively promote sustainability by working together. In a multi-agency group setting, project goals are sufficiently evaluated, the pros and cons of design and construction alternatives are discussed, and solutions can be negotiated when one agency's interest may conflict with another agency's. Frequently, these communications can and should occur at the technical staff level, as opposed to the administrative managerial level only.

Sustainable design and construction does not always imply higher costs, and even when additional funds are needed, they are usually only a few percent of the total building costs. For example, one building at the CAEEC (Block 225) has more than 100 sustainable building features accounting for only 2.5% of the contract cost excluding the raised-floor air-distribution system, or 8.2% including the raised floor air-distribution system. These increases are expected to be offset by savings over the life of the building from improved worker health and productivity and from reduced long-term operational and maintenance costs.

Increased ventilation for enhanced indoor air quality does not necessarily imply energy penalties. Block 225 of the CAEEC is designed to supply 12L/s (25cfm) of outdoor airflow rate per person. This is in excess of the 7 L/s (15 cfm) per person [or 0.76 L/s/m<sup>2</sup> (0.15cfm/ft<sup>2</sup>), whichever is greater] as required by the State's energy code (California Energy Commission, 1998). Even with this higher ventilation rate, this building will still exceed the project's overall goal of 30% better energy efficiency than the State's 1998 energy code. The expected energy savings for this building are \$183,400 (in 2001 dollars) (Bernheim, 2001).

Sustainable procurement specifications do not always result in increased prices, especially if the procuring organization has a large purchasing power. In the case of the office furniture systems contract, the State is now paying a price comparable to its previous contract, which did not include any environmental specifications.

Inclusion of sustainable specifications must start before conceptual design so that it is incorporated into the scope of the project as well as the budget estimates. As the project is developed, all contractors and subcontractors must be aware of the sustainable goals of the project. Inclusion of these goals in RFP documents does not necessarily guarantee their implementation in the construction. Due to the nature of the building design and construction industry, changes and modifications are a usual occurrence. These changes and modifications could be the result of "value engineering", the availability of new products, owner changes, etc. In large-scale projects, it is important that the owner retains a knowledgeable consultant to oversee the implementation of all sustainable goals and measures throughout the project.

Although the idea of building commissioning has been around for years, there are very few buildings that have implemented the idea of whole-building commissioning. Usually building commissioning is limited to mechanical as well as life safety equipment and devices. Incorporating non-traditional features in a commissioning plan, such as indoor air quality sampling and building material certification, will add a great value to the commissioning process.

## **CONCLUSION AND IMPLICATIONS**

Because California's economy is one of the largest in the world (was the fifth in 2000), any market transformation initiated in this State will likely have large-scale impacts. For example, sustainable building specifications developed by the State of California, such as those developed for building materials, could have not only national but international implications for building design, construction, maintenance, and operation in the future. Similarly, given its multi-million-dollar purchasing power, commodity specifications developed for California, such as those developed for office furniture systems, will help drive a broad range of industries towards manufacturing more sustainable products.

California's recent energy crisis has made both the public and private sector even more aware of environmental and resource conservation issues. With proper planning, sustainable building design not only reduces a building's energy demand, but enhances indoor air quality, reduces water consumption, and maximizes the use of environmentally-friendly materials and products. Governor Davis's Executive Order provides the mechanism for implementing sustainable building practices by using resources more efficiently while providing better performing, more comfortable, and healthier indoor environments.

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## REFERENCES

- Alevantis LE. 2000. Indoor Air Quality-Related Legislation in California (USA), *Proceedings: Workshop on Urban Air, Indoor Environment and Human Exposure: Future Needs for Policy-Science Interface in the EU*. EUR 19646. Kephelopoulos S, Jantunen M, and Kotzias D, eds. Italy: European Commission, pp. 37-41.
- Bernheim A. 2001. Saving resources. *Urban Land*. June 2001, pp.76-81.
- Bernheim A, Levin H, Alevantis L. 2002. Special Environmental Requirements for a California State Office Building. Submitted for presentation at the 9<sup>th</sup> International Conference on Indoor Air Quality and Climate – Indoor Air 2002. Santa Cruz: Indoor Air 2002.
- California Energy Commission. 1998. *Energy Efficiency Standards for Residential and NonResidential Buildings*. Subchapter 3, Section 121. Available on the web at: [http://www.energy.ca.gov/title24\\_1998\\_standards/index.html](http://www.energy.ca.gov/title24_1998_standards/index.html)
- California Energy Commission. 2001. Special Environmental Requirements – Section 01350. In *Reference Specifications for Energy and Resource Efficiency*. Public Interest Energy Research (PIER). Available at <http://www.eley.com>
- Collaborative for High Performance Schools (CHPS). 2001. Special Environmental Requirements–Section 01350. In *Best Practices Manual*. Available at <http://www.chps.net>
- Department of General Services, 2000. Project Management Branch. East End Home Page. <http://www.resd.dgs.ca.gov/projects/eastend/default.asp?mp=GreenPage/main.asp>
- Fisk, W.J. 2000. Health and Productivity Gains From Better Indoor Environments and Their Relationship with Building Energy Efficiency, *Ann.Rev. Energy Environ.*, 25: 537-566
- Levin H, Alevantis L, Muller R, and Flamm G.. 2000. Final Environmental Specifications to Be Included in the Bid Documents for Office Furniture Systems. State of California, Department of General Services, Procurement Division. December 18, 2000. Available at <http://www.ciwmb.ca.gov/GreenBuilding/Specs/>
- State of California. 2000. Governor's Executive Order D-16-00. August 2000. Available at: [http://www.governor.ca.gov/state/govsite/gov\\_homepage.jsp](http://www.governor.ca.gov/state/govsite/gov_homepage.jsp)
- State of California. 2001. *Building Better Buildings: A Blueprint for Sustainable State Facilities*.” Released December 2001. Available at: <http://www.ciwmb.ca.gov/GreenBuilding/Blueprint>